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CLAIMS

1. An electrical machine for converting electrical energy into mechanical energy and/or mechanical energy into electrical energy, the machine comprising:

a rotor having a plurality of rotor poles;

a stator for rotatably receiving said rotor and having field magnet means for generating a first magnetomotive force between said rotor and said stator, the stator incorporating at least two electrical windings at least one which is an armature winding adapted to carry electrical current varying in synchronism with rotation of said rotor relative to said stator to generate a varying second magnetomotive force having a component transverse to said first magnetomotive force;

control means for controlling supply of electrical current to the or each said armature winding; and

position sensing means for detecting at least one induced first electrical signal dependent on rotational position of said rotor relative to said stator, the or each said first electrical signal being induced in a respective one of said windings by a voltage across at least one other of said windings, said voltage being a requirement of normal operation of the machine to convert electrical energy into mechanical energy and/or mechanical energy into electrical energy, to thereby supply at least one second electrical signal to said control means representative of the rotational position of said rotor relative to said stator.

2. A machine according to claim 1, wherein said stator has a plurality of stator poles, and at least one said armature winding is wound with a pitch corresponding to a plurality of stator pole pitches.

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3. A machine according to claim 1 or 2, wherein said field magnet means includes at least one field winding adapted to be connected in series or in parallel with a circuit containing at least one said armature winding.

4. A machine according to claim 3, wherein the position sensing means is adapted to detect said at least one induced first electrical signal in said at least one field winding.

5. A machine according to any one of the preceding claims, wherein the position sensing means is adapted to detect when at least one said induced first electrical signal passes through at least one threshold value to produce said at least one second electrical signal.

6. A machine according to claim 5, wherein the position sensing means is adapted to detect when at least one said induced first electrical signal passes through at least one respective threshold value when at least one of said windings is energized with substantially uniform voltage and/or when at least one of said windings is not energized, said voltage being a requirement of normal operation of the machine to convert electrical energy into mechanical energy and/or mechanical energy into electrical energy.

7. A machine according to claim 5 or 6, wherein the position sensing means is adapted to determine when to begin and/or end energisation of at least one said armature winding by determining relative proportions of time for which at least one said induced first electrical signal is greater than or less than at least one respective threshold value in at least one of said windings during a predetermined period of rotation of said rotor.

8. A machine according to claim 7, wherein the position sensing means is adapted to control timing of energisation of at least one said armature winding to maintain relative proportions of time for which said at least one induced first electrical signal is greater than or less than at least one respective threshold value in at least one of said windings within predetermined limits.

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9. A machine according to claim 8, wherein the predetermined limits are adapted to vary in dependence upon output performance of said machine.

10. A machine according to claim 8 or 9, wherein the position sensing means is adapted to control timing of said energisation by means of at least one error signal input to said control means.

11. A machine according to any one of claims 8 to 10, wherein the position sensing means is adapted to selectively control timing of said energisation in response to failure to detect at least one said induced first electrical signal passing through a threshold value during a predetermined period.

12. A machine according to any one of claims 5 to 11, wherein the position sensing means is adapted to detect when at least one said induced first electrical signal passes through at least one respective threshold value to produce at least one said second electrical signal, at least one said threshold value being a function of the corresponding said induced first electrical signal.

13. A machine according to any one of the preceding claims, wherein the position sensing means is adapted to extract at least one said induced first electrical signal dependent on rotational position of said rotor relative to said stator, from the rate of change of current occurring in an electrical winding of the machine arising as a result of the existence of a voltage across at least one of said windings.

14. A machine according to claim 13, wherein the position sensing means includes at least one respective coil adapted to be magnetically coupled to a magnetic field generated by a conductor carrying current passing through at least one of said windings.

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15. A machine according to any one of the preceding claims, wherein the position sensing means is adapted to obtain data relating to at least one said induced first electrical signal and compare said data with data relating to at least one known rotor position.

16. A machine according to any one of the preceding claims, wherein the position sensing means is adapted to provide at least one said second electrical signal representative of rotational position of the rotor at standstill by determining at least one said induced first electrical signal in at least one of said windings when at least one other of said windings is energised.

17. A machine according to claim 16, wherein the control means is adapted to cause said rotor to move relative to said stator to a position of stable equilibrium in response to at least one said second electrical signal from said position sensing means generated at standstill of said rotor.

18. A machine according to claim 17, wherein the position sensing means is adapted to indicate the nearest position of stable equilibrium of said rotor relative to said stator by observing the respective said induced first electrical signal in said at least one winding when said at least one other winding is energized.

19. A machine according to any one of the preceding claims, wherein the position sensing means is adapted to monitor at least one said induced first electrical signal by intermittently sampling said signal.

20. A machine according to any one of the preceding claims, wherein the position sensing means is adapted to monitor at least one said second electrical signal by intermittently sampling said signal.

21. A machine according to any one of the preceding claims, wherein the position sensing

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means is adapted to detect the rate of change of said at least one induced first electrical signal caused by a change in the magnetic flux through said winding.

22. A method of controlling an electrical machine for converting electrical energy into mechanical energy and/or mechanical energy into electrical energy, the machine comprising a rotor having a plurality of rotor poles and a stator for rotatably receiving said rotor and having field magnet means for generating a first magnetomotive force between said rotor and said stator, the stator having at least two electrical windings at least one of which is a respective armature winding adapted to carry electrical current varying in synchronism with rotation of said rotor relative to said stator to generate a varying second magnetomotive force having a component transverse to said first magnetomotive force, the method comprising the steps of:

detecting at least one induced first electrical signal dependent on rotational position of said rotor relative to said stator, the or each said first electrical signal being induced in a respective one of said windings by a voltage across at least one other of said windings, said voltage being a requirement of normal operation of the machine to convert electrical energy into mechanical energy and/or mechanical energy into electrical energy;

supplying at least one second electrical signal representative of the rotational position of said rotor relative to said stator; and

controlling supply of electrical current to the or each said armature winding in response to at least one said second electrical signal.

23. A method according to claim 22, wherein the detection of said at least one induced first electrical signal comprises detecting at least one said induced first electrical signal in at least one field winding of said field magnet means.

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24. A method according to claim 22 or 23, wherein the detection of said at least one induced first electrical signal comprises detecting when at least one said induced first electrical signal passes through at least one threshold value to produce at least one said second electrical signal.

25. A method according to claim 24, wherein the detection of said at least one induced first electrical signal comprises detecting when at least one induced first electrical signal passes through at least one respective threshold value when at least one of said windings is energized with substantially uniform voltage and/or when at least one of said windings is not energized, said voltage being a requirement of normal operation of the machine to convert electrical energy into mechanical energy and/or mechanical energy into electrical energy.

26. A method according to claim 24 or 25, further comprising the step of determining when to begin and/or end energisation of at least one said armature winding by determining relative proportions of time for which at least one said induced first electrical signal is greater than or less than at least one respective threshold value in at least one of said windings during a predetermined period of rotation of said rotor.

27. A method according to claim 26, further comprising the step of controlling timing of energisation of at least one said armature winding to maintain relative proportions of time for which at least one said induced first electrical signal is greater than or less than at least one respective threshold value in at least one of said windings within predetermined limits.

28. A method according to claim 27, further comprising the step of varying said predetermined limits in dependence upon output performance of said machine.

29. A method according to any one of claims 22 to 28, further comprising the step of controlling timing of said energisation by means of at least one error signal.

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30. A method according to claim 29, further comprising the step of selectively controlling timing of said energisation in response to failure to detect at least one said induced first electrical signal passing through a threshold value during a predetermined period.

31. A method according to any one of claims 22 to 30, wherein the detection of said at least one induced first electrical signal comprises detecting when at least one said induced first electrical signal passes through at least one respective threshold value to produce at least one said second electrical signal, at least one said threshold value being a function of an average value of the corresponding said induced first electrical signal.

32. A method according to any one of claims 22 to 31, further comprising the step of extracting at least one said induced first electrical signal dependent on rotational position of said rotor relative to said stator, from the rate of change of current occurring in one of said windings arising as a result of the existence of a voltage across one or more other of said windings.

33. A method according to any one of claims 22 to 32, further comprising the step of obtaining data relating to at least one said induced first electrical signal and comparing said data with data relating to at least one known rotor position.

34. A method according to any one of claims 22 to 33, further comprising the step of providing at least one said second electrical signal representative of rotational position of said rotor at standstill by determining at least one said induced first electrical signal in at least one of said windings when at least one other of said windings is energised.

35. A method according to claim 34, further comprising the step of causing said rotor to move relative to said stator to a position of stable equilibrium in response to at least one said second electrical signal from said position sensing means generated at standstill of said rotor.

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36. A method according to claim 35, further comprising the step of indicating the nearest position of stable equilibrium of said rotor relative to said stator by observing the respective said induced first electrical signal in at least one of said windings when at least one other of said windings is energized.

37. A method according to any one of claims 22 to 36, further comprising the step of monitoring at least one said induced first electrical signal by intermittently sampling said signal.

38. A method according to any one of claims 22 to 37, further comprising the step of monitoring at least one said second electrical signal by intermittently sampling said signal.

39. A method according to any one of claims 22 to 38, wherein the detecting of said at least one first electrical signal dependent on rotational position of said rotor comprises detecting the rate of change of said at least one induced first electrical signal caused by a change in the magnetic flux through said winding.

40. A method of determining the rate of change of current in at least one winding of an electrical machine for converting electrical energy into mechanical energy and/or mechanical energy into electrical energy, the method comprising monitoring a voltage induced in at least one respective coil magnetically coupled to a magnetic field generated by a conductor carrying said current.